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HYBRID SIMULATION OF THE HYDRAULIC CHARACTERISTICS AT RIVER AND LAKE CONFLUENCE *

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Abstract: The hydraulic characteristics at the confluence reach of river and lake are influenced by multiple factors such as inflow, topography and vegetation resistance, and are very complicated. In this article, the confluence reach of Yangtze River and Dong-ting Lake is selected as a special example and a hybrid model is built to study the flow at this confluence, with the consideration of the interactions between aquatic vegetation and flow. Validation tests and calculations show that the model is effective and highly accurate. The simulations show that the separation levee at the confluence reach may change the discharge capacity in the flood plain, which would be enhanced in the upper reach of the levee, hardly changed in the middle reach and reduced at the lower place. Moreover, the separation levee also limits the water exchange between the Yangtze River and Dong-ting Lake.

Key words: confluence reach, hybrid model, separation levee, discharge capacity in flood plain

Introduction

River and lake confluences ubiquitously exist in nature, such as one between the Yangtze River and Dong-ting Lake, or one between the Yangtze River and the Po-yang Lake along the Yangtze River. The hydraulic characteristics at the confluence reach are very complicated due to river topography, inflow conditions and vegetation in flood plain, and the related studies would be beneficial to the understanding of river-lake relation, flood control as well as navigation.

Currently, there are three kinds of methods used to study the water flow at confluence, i.e., field data analysis, numerical simulation and physical model experiment. Luo et al.[1] studied the interaction between the Jingjiang River and Dong-ting Lake by analyzing the measured runoff and sediment discharge processes. Biron et al.[2], by using a three-dimensional mathematical model, studied effects of the riverbed discordance between the main stream and the tributary with the lateral mixing of pollutants at river confluence. Liu and Guo[3] conducted experimental researches on the variation of the water surface slope and the velocity distribution at the junction of rectangular channels. However, the above three methods, if being separately applied, have their own defects in studying the characteristics of the flow movement at the confluence reach. By using field data analysis alone, the precision can not be very high because field data observations are influenced by various observation conditions. The mathematical models are mostly at the levels of 2-D[4] simulation and 3-D simulation[5], the former is subject to the hydrostatic pressure assumption in simulating river flow at the complicated river topography of the confluence, and the latter requires to be improved with respect to free surface treatment. As to the physical model experiment, if being used alone, its simulation results will be affected by the scale effect in a small scale model or the method will turn out to be uneconomical in a large scale model. At present, the hybrid simulation method[6,7] has become increasingly popular in studying intricate flow movements, but, so far, it has not been used in studying the flow at the confluence reach. The flood plain at the confluence of the river and the lake is usually covered with aquatic vegetation, which would markedly affect the movement of the flow in the flood plain. The flows through vegetation were extensively studied[8-13],

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